REMARKS

Claims 1, 4, 5, 7, and 8 are pending in the present application.

Claims 2, 3, and 6 have been cancelled without prejudice or disclaimer to the subject matter contained therein.

I. ARGUMENTS

A. Objection to the Drawings

The drawings have been objected for various reasons. These objections are respectfully traversed in view of the above-submitted amendments to the Specification and drawings.

As submitted above, the specification has been amended to clarify the relationship between reference 30 of Figure 2 and source 12 of Figure 1. More specifically, Figure 1 has been amended to show the connection between the check valve and the reservoir. Figure 2 has been amended to identify the outlet 30 of source (12).

No new subject matter has been added in these amendments.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw these objections to the drawings.

B. Objection to the Specification

The specification has been objected for various reasons. This objection is respectfully traversed in view of the above-submitted amendments to the specification and claims.

As submitted above, the specification has been amended to indicate that the beryllium target 32 produces a neutron flux. Moreover, the specification has been amended such that the description of Figure 1 does not recite element 30. Also, the specification has been amended to clarify the relationship between reference 30 of Figure 2 and source 12 of Figure 2.

No new subject matter has been added in these amendments.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this objection.

C. Rejection of Claims 1, 2, and 4 - 8 under 35 U.S.C. §112, First Paragraph

Claims 1, 2, and 4-8 have been rejected under 35 U.S.C. §112, first paragraph, for failing to provide a written description of the claimed invention. This rejection, in view of the above amendments, is moot.

In formulating the rejection under 35 U.S.C. §112, first paragraph, the Examiner alleges that the originally filed specification fails to provide a written description of a nozzle submerged in liquid gallium.

Figure 2 is a cross-sectional illustration of the neutron generating portion of the accelerator based neutron source 12 of Figure 1 and associated cooling system. The portion of the accelerator based neutron source 12, as set forth in the originally filed specification, includes a stainless steel housing 31 within which is a beryllium target 32. This target is bombarded with either protons or deuterons on a surface 33 of the beryllium target 32. As a result of proton or deuteron interactions in the beryllium target 32, neutrons are generated and pass through the gallium-filled reservoir and stainless steel housing and are emitted from the accelerator based neutron source 12, as set forth in the originally filed specification. Since the heat flux in the beryllium is extremely high, the present invention utilizes liquid gallium to cool the beryllium target 32.

The accelerator based neutron source 12, as illustrated in original Figure 2 and as set forth in the originally filed specification, includes a stainless steel nozzle 34 that receives the liquid gallium and injects a concentrated jet of liquid gallium 37 onto the back surface 39 of the beryllium target 32. Since the outlet 30, as illustrated in original Figure 2, from the stainless steel housing 31 is located above the top surface of the beryllium target 32, the reservoir 40 will fill with liquid gallium, as set forth in the originally filed specification.

Thus, the originally filed specification teaches that the jet of liquid gallium 37 is submerged in the reservoir 40 because the reservoir 40 will fill with liquid gallium.

The liquid gallium will exit out of the housing through the outlet 30 where it will be piped to the heat exchanger 24 to remove the latent heat.

Accordingly, in view of the remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

D. Rejection of Claims 1 and 5 under 35 U.S.C. §103

Claims 1 and 5 have been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US-A-5,392,319) in view of Lidsky et al. (US-A-5,784,423) and Pias et al. (IEEE Article). This rejection is respectfully traversed.

Independent Claim 1

As submitted above, independent claim 1 has been amended to set forth a method of cooling a low Z target material of a neutron source assembly by providing, by using a nozzle submerged in liquid gallium, a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the neutron source assembly to cool the low Z target material; providing a reservoir of liquid gallium; and pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the

teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth in amended independent claim 1.

With respect to the teachings of Alger et al., Alger et al. discloses cooling system wherein the coolant leaving the target chamber 13 is returned to the reservoir 23. Moreover, Alger et al. discloses that the coolant in the reservoir 23 can go to either the pump 27 for cooling the target or to cooling system 28 for temperature reduction.

Thus, Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target

material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth in amended independent claim 1.

Since Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth in amended independent claim 1.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth in amended independent claim 1.

Independent Claim 5

As submitted above, independent claim 5 has been amended to set forth a neutron source assembly having a liquid cooled target. The neutron source assembly includes an accelerator based neutron source including a low Z target material that is bombarded by accelerated particles to produce a neutron flux and a cooling system to circulate liquid gallium through the accelerator based neutron source to cool the low Z target material. The cooling system includes a nozzle, the nozzle being submerged in liquid gallium to provide a submerged jet of concentrated liquid

gallium in a direction normal to a non-bombarded surface of the low Z target material within the accelerator based neutron source. The cooling system further includes a reservoir of liquid gallium; a heat exchanger, and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 5.

With respect to the teachings of Alger et al., Alger et al. discloses cooling system wherein the coolant leaving the target chamber 13 is returned to the reservoir 23. Moreover, Alger et al. discloses that the coolant in the reservoir 23 can go to either the pump 27 for cooling the target or to cooling system 28 for temperature reduction.

Thus, Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 5.

Since Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest

means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 5.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 5.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

E. Rejection of Claim 8 under 35 U.S.C. §103

Claim 8 has been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US-A-5,392,319) in view of Lidsky et al. (US-A-5,784,423), Pias et al. (IEEE Article), and Alger et al. (US-A-4,141,224). This rejection is respectfully traversed.

As submitted above, independent claim 8 has been amended to set forth a liquid cooling system for a neutron source assembly. The cooling system includes a reservoir of liquid gallium; a heat exchanger; a nozzle, the nozzle being submerged in liquid gallium, to provide a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of a low Z target material within the neutron source assembly; and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the

Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al.

fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 8.

With respect to the teachings of Alger et al., Alger et al. discloses cooling system wherein the coolant leaving the target chamber 13 is returned to the reservoir 23. Moreover, Alger et al. discloses that the coolant in the reservoir 23 can go to either the pump 27 for cooling the target or to cooling system 28 for temperature reduction.

Thus, Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 8.

Since Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 8.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest means for serially circulating the liquid gallium from the reservoir through the nozzle to

impinge upon the surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir, as set forth in amended independent claim 8.

Accordingly, in view of the amendments and remarks set forth above, the Examiner is respectfully requested to reconsider and withdraw this rejection.

CONCLUSION

Accordingly, in view of all the amendments and reasons set forth above, the Examiner is respectfully requested to reconsider and withdraw all the present rejections. Also, an early indication of allowability is earnestly solicited.

Respectfully submitted,

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